Table A-3-a V-Band Link: Tokyo U/L to Honolulu D/L - 2.5 m Terminals

SUMMARY of Uplink Budget				
Sat. Long. @ 155 deg East	Clear		Rain	Units
Terminal Location & Size:	Tokyo	2.5		meter
Site Elevation Angle	45.5			deg
Site Altitude (ASL)	0.0			km
Frequency	48.7			GHz
Link Availability			99.00	%
Application Data Rate	155			Mbps
Station Transmitter Power	50.0			W
Transmitter Pwr (dBW)	17.0			dBW
Uplink Power Back-off	2.5		0	dB
# of Amplified Carriers	10			
Station Transmitter Losses	1.0			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	59.5			dBi
Total EIRP per beam		73.0	75.5	
Operating EIRP per carrier		63.0	65.5	dBW
Space Loss		217.6	217.6	dB
Atm. (Gas + Cloud) Att.		4.2	4.4	dB
Rain Attenuation			7.3	dB
Pointing and Pol. Loss		0.5	0.5	dB
Sat. Antenna Gain	55.0			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		26.4	26.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		12.6	7.7	dB
Total U/L C/I	15.0			dB
U/L C/(Io)		98.0	98.0	dB/Hz
Thermal U/L C/(No)		95.7	90.7	dB/Hz
Total D/L C/I	15.4			dB
D/L C/(Io)		98.4	98.4	dB/Hz
Thermal D/L C/(No)		102.0	91.7	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		88.9	88.9	dB/Hz

SUMMARY of Downlink Budget				
	Clear		Rain	Units
Terminal Location & Size:	Honolulu	2.50		meter
Site Elevation Angle	31.9			deg
Site Altitude (ASL)	0.0			km
Frequency	41.0			GHz
Link Availability			99.00	%
Link Data Rate	155			Mbps
Satellite TWTA Rating	100			W
Sat. Transmit Power	20.0			dBW
Sat. HPA Backoff	2.0			dB
# of Amplified Carriers	10			
Transmitter Total losses	1			dB
Sat Min. Ant. Gain	55.0			dBi
Total EIRP per beam	72.0			dBW
Operating EIRP/carrier		62.0	62.0	dBW
Space Loss		216.4	216.4	dB
Atm. (Gas + Cloud) Attenuation		2.7	2.8	dB
Rain Attenuation			8.6	dB
User Ant. Pointing Losses		0.5	0.5	dB
Recvr. Antenna Gain	58.0			dBi
System Noise Temp	451.2		654.2	°K
System Noise Temp	26.5		28.2	dBK
Station G/T		31.0	29.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		19.0	8.7	dB
Uplink Conditions	clear	rain	clear	
Downlink Conditions	clear	clear	rain	
U/L C/(No) (dB/Hz)	95.7	90.7	95.7	dB/Hz
U/L C/(Io) (dB/Hz)	98.0	98.0	98.0	dB/Hz
U/L C/(No+Io) (dB/Hz	93.6	89.9	93.6	dB/Hz
D/L C/(No) (dB/Hz)	102.0	100.7	91.7	dB/Hz
D/L C/(Io) (dB/Hz)	98.4	98.4	98.4	dB/Hz
D/L C/(No+Io) (dB/Hz	96.8	96.4	90.8	dB/Hz
Total C/(No+Io) (dB/Hz)	91.9	89.0	89.0	dB/Hz
Required C/No (dB/Hz)	88.9	88.9	88.9	dB/Hz
Margin (dB)	3.0	0.1	0.1	dB

Table A-3-b V-Band Link: Honolulu U/L to Seattle D/L - 2.5 m Terminals

SUMMARY of Uplink Budget				
Sat. Long. @ -125 deg East	Clear		Rain	Units
Terminal Location & Size:	Honolulu	2.5		meter
Site Elevation Angle	45.4			deg
Site Altitude (ASL)	0.0			km
Frequency	48.7			GHz
Link Availability			99.00	%
Application Data Rate	155			Mbps
Station Transmitter Power	50.0			W
Transmitter Pwr (dBW)	17.0			dBW
Uplink Power Back-off	2.5		0	dB
# of Amplified Carriers	10			
Station Transmitter Losses	1.0			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	59.5			dBi
Total EIRP per beam		73.0	75.5	
Operating EIRP per carrier		63.0	65.5	dBW
Space Loss		217.6	217.6	dB
Atm. (Gas + Cloud) Att.		3.8	3.8	dB
Rain Attenuation			7.5	dB
Pointing and Pol. Loss		0.5	0.5	dB
Sat. Antenna Gain	55.0			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		26.4	26.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		13.1	8.0	dB
Total U/L C/I	15.0			dB
U/L C/(Io)		98.0	98.0	dB/Hz
Thermal U/L C/(No)		96.1	91.0	dB/Hz
Total D/L C/I	15.4			dB
D/L C/(Io)		98.4	98.4	dB/Hz
Thermal D/L C/(No)		103.1	91.3	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		88.9	88.9	dB/Hz

SUMMARY of Downlink Budget				
	Clear		Rain	Units
Terminal Location & Size:	Seattle	2.50		meter
Site Elevation Angle	35.2			deg
Site Altitude (ASL)	0.0			km
Frequency	41.0			GHz
Link Availability			99.88	%
Link Data Rate	155			Mbps
Satellite TWTA Rating	100			W
Sat. Transmit Power	20.0			dBW
Sat. HPA Backoff	2.0			dB
# of Amplified Carriers	10			
Transmitter Total losses	1			dB
Sat Min. Ant. Gain	55.0			dBi
Total EIRP per beam	72.0			dBW
Operating EIRP/carrier		62.0	62.0	dBW
Space Loss		216.3	216.3	dB
Atm. (Gas + Cloud) Attenuation		2.5	2.6	dB
Rain Attenuation			10.0	dB
User Ant. Pointing Losses		0.5	0.5	dB
Recvr. Antenna Gain	58.7			dBi
System Noise Temp	441.9		653.3	°K
System Noise Temp	26.5		28.2	dBK
Station G/T		31.8	30.1	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		20.1	8.3	dB
Uplink Conditions	clear	rain	clear	
Downlink Conditions	clear	clear	rain	
U/L C/(No) (dB/Hz)	96.1	91.0	96.1	dB/Hz
U/L C/(Io) (dB/Hz)	98.0	98.0	98.0	dB/Hz
U/L C/(No+Io) (dB/Hz	93.9	90.2	93.9	dB/Hz
D/L C/(No) (dB/Hz)	103.1	102.0	91.3	dB/Hz
D/L C/(Io) (dB/Hz)	98.4	98.4	98.4	dB/Hz
D/L C/(No+Io) (dB/Hz	97.1	96.8	90.6	dB/Hz
Total C/(No+Io) (dB/Hz)	92.2	89.3	88.9	dB/Hz
Required C/No (dB/Hz)	88.9	88.9	88.9	dB/Hz
Margin (dB)	3.3	0.4	0.0	dB

Table A-4-a Ku-Band Link: Singapore U/L to Midway D/L - 2.5 m Terminals

SUMMARY of Uplink Budget

Sat.long. @ 155 deg East	Clear		Rain	Units
Terminal Location & Size:	**Singapore**	**2.5**		meter
Site Elevation Angle	31.1			deg
Site Altitude (ASL)	0.0			km
Frequency	13.0			GHz
Link Availability			99.40	%
Application Data Rate	155			Mbps
Station Transmitter Power	100.0			W
Transmitter Pwr (dBW)	20.0			dBW
Uplink Power Back-off	1.0		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	0.3			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	48.8			dBi
Total EIRP per beam		67.5	68.5	
Operating EIRP per carrier		67.5	68.5	dBW
Space Loss		206.4	206.4	dB
Atm. (Gas + Cloud) Att.		0.5	0.5	dB
Rain Attenuation			7.2	dB
Pointing and Pol. Loss		0.4	0.4	dB
Sat. Antenna Gain	33.5			dBi
System Noise Temp	365.1			'K
System Noise Temp	25.6			dBK
Satellite G/T		7.4	7.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		13.1	6.9	dB
Total U/L C/I	16.6			dB
U/L C/(Io)		99.6	99.6	dB/Hz
Thermal U/L C/(No)		96.1	89.9	dB/Hz
Total D/L C/I	15.8			dB
D/L C/(Io)		98.8	98.8	dB/Hz
Thermal D/L C/(No)		105.5	100.6	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		88.9	88.9	dB/Hz

SUMMARY of Downlink Budget

	Clear		Rain	Units
Terminal Location & Size:	**Midway**	**2.50**		meter
Site Elevation Angle	45.2			deg
Site Altitude (ASL)	0.0			km
Frequency	11.0			GHz
Link Availability			99.94	%
Link Data Rate	155			Mbps
Satellite TWTA Rating	150			W
Sat. Transmit Power	21.8			dBW
Sat. HPA Backoff	0.0			dB
# of Amplified Carriers	1			
Transmitter Total losses	0.6			dB
Sat Min. Ant. Gain	33.5			dBi
Total EIRP per beam	54.7			dBW
Operating EIRP/carrier		54.7	54.7	dBW
Space Loss		204.7	204.7	dB
Atm. (Gas + Cloud) Attenuation		0.2	0.2	dB
Rain Attenuation			1.9	dB
User Ant. Pointing Losses		0.4	0.4	dB
Recvr. Antenna Gain	47.3			dBi
System Noise Temp	89.0		174.8	'K
System Noise Temp	19.5		22.4	dBK
Station G/T		27.5	24.6	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		22.5	17.6	dB

Uplink Conditions	clear	rain	clear	
Downlink Conditions	clear	clear	rain	
U/L C/(No) (dB/Hz)	96.1	89.9	96.1	dB/Hz
U/L C/(Io) (dB/Hz)	99.6	99.6	99.6	dB/Hz
U/L C/(No+Io) (dB/Hz	94.5	89.5	94.5	dB/Hz
D/L C/(No) (dB/Hz)	105.5	103.8	100.6	dB/Hz
D/L C/(Io) (dB/Hz)	98.8	98.8	98.8	dB/Hz
D/L C/(No+Io) (dB/Hz	97.9	97.6	96.6	dB/Hz
Total C/(No+Io) (dB/Hz)	92.9	88.9	92.4	dB/Hz
Required C/No (dB/Hz)	88.9	88.9	88.9	dB/Hz
Margin (dB)	4.0	0.0	3.5	dB

Table A-4-b Ku-Band Link: Midway U/L to Seattle D/L - 2.5 m Terminals

SUMMARY of Uplink Budget

Sat.long. @ -125 deg East	Clear		Rain	Units
Terminal Location & Size:	**Midway**	**2.5**		meter
Site Elevation Angle	24.6			deg
Site Altitude (ASL)	0.0			km
Frequency	13.0			GHz
Link Availability			99.92	%
Application Data Rate	155			Mbps
Station Transmitter Power	50.0			W
Transmitter Pwr (dBW)	17.0			dBW
Uplink Power Back-off	1.0		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	0.3			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	48.8			dBi
Total EIRP per beam		64.5	65.5	
Operating EIRP per carrier		64.5	65.5	dBW
Space Loss		206.6	206.6	dB
Atm. (Gas + Cloud) Att.		0.4	0.4	dB
Rain Attenuation			3.9	dB
Pointing and Pol. Loss		0.4	0.4	dB
Sat. Antenna Gain	33.5			dBi
System Noise Temp	365.1			'K
System Noise Temp	25.6			dBK
Satellite G/T		7.4	7.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		10.1	7.2	dB
Total U/L C/I	16.1			dB
U/L C/(Io)		99.1	99.1	dB/Hz
Thermal U/L C/(No)		93.1	90.2	dB/Hz
Total D/L C/I	15.8			dB
D/L C/(Io)		98.8	98.8	dB/Hz
Thermal D/L C/(No)		105.1	95.7	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		88.9	88.9	dB/Hz

SUMMARY of Downlink Budget

	Clear		Rain	Units
Terminal Location & Size:	**Seattle**	**2.50**		meter
Site Elevation Angle	35.2			deg
Site Altitude (ASL)	0.0			km
Frequency	11.0			GHz
Link Availability			99.99	%
Link Data Rate	155			Mbps
Satellite TWTA Rating	150			W
Sat. Transmit Power	21.8			dBW
Sat. HPA Backoff	0.0			dB
# of Amplified Carriers	1			
Transmitter Total losses	0.6			dB
Sat Min. Ant. Gain	33.5			dBi
Total EIRP per beam	54.7			dBW
Operating EIRP/carrier		54.7	54.7	dBW
Space Loss		204.9	204.9	dB
Atm. (Gas + Cloud) Attenuation		0.2	0.2	dB
Rain Attenuation			5.0	dB
User Ant. Pointing Losses		0.4	0.4	dB
Recvr. Antenna Gain	47.3			dBi
System Noise Temp	91.4		257.1	'K
System Noise Temp	19.6		24.1	dBK
Station G/T		27.4	22.9	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		22.1	12.7	dB

Uplink Conditions	clear	rain	clear	
Downlink Conditions	clear	clear	rain	
U/L C/(No) (dB/Hz)	93.1	90.2	93.1	dB/Hz
U/L C/(Io) (dB/Hz)	99.1	99.1	99.1	dB/Hz
U/L C/(No+Io) (dB/Hz	92.1	89.6	92.1	dB/Hz
D/L C/(No) (dB/Hz)	105.1	103.6	95.7	dB/Hz
D/L C/(Io) (dB/Hz)	98.8	98.8	98.8	dB/Hz
D/L C/(No+Io) (dB/Hz	97.9	97.5	93.9	dB/Hz
Total C/(No+Io) (dB/Hz)	91.1	89.0	89.9	dB/Hz
Required C/No (dB/Hz)	88.9	88.9	88.9	dB/Hz
Margin (dB)	2.2	0.1	1.0	dB

Table A-5. Ku-Band Telemetry Link

Parameter	Spot Antenna	Omni Pipe	Comments
Minimum EIRP, dBW	8.0	0.0	Estimate
Path Loss, dB/m^{-2}	-162.5	-162.5	40° elevation
Atmospheric Absorption, dB	-0.2	-0.2	Estimate; clear sky
Isotropic Area, dB-m^2	-42.0	-42.0	10700 MHz
Ground Station G/T, dB/°K	34.2	34.2	7-m antenna
Tracking Loss	-0.1	-0.1	
Polarization Mismatch, dB	-0.1	-0.1	
Boltzmann's Constant, dBW/°K-Hz	-228.6	-228.6	
Downlink C/No. @ TM Receiver, dB-Hz	65.8	57.8	
Minimum C/No @ TM Receiver, dB-Hz	53.0	53.0	For 4 Kbps stream
Clear Weather C/No Margin, dB	12.8	4.8	1.0 dB rain fade for 99.95% availability
S/No Computation for Ranging:			
Demodulation Factor, dB	-5.2	-5.2	when carrier is at minimum
Receiver Baseband S/No, dB-Hz	60.6	52.6	modulation index
Carrier Recovery:			
TM Receiver Loop Bandwidth, dB-Hz	40.0	40.0	10 kHz PM demod PLL BW
Carrier Power Factor, dB	-3.2	-3.2	when carrier is at maximum
Margin, dB	16.7	8.7	modulation index
Subcarrier Recovery:			
TM Receiver IF Bandwidth, dB-Hz	57.0	57.0	500 kHz BW
Subcarrier Power Factor, dB	-5.2	-5.2	when carrier is at minimum
Margin, dB	18.6	10.6	modulation index
BER Computation:			
Demodulation Factor, dB	-5.2	-5.2	
Implementation Loss, dB	-2.5	-2.5	
Margin, dB	11.6	3.6	for 10^{-6} bit error rate

Table A-6. Ku-Band Command Links

SpaceCast Ku-band On-station Planar Array Command Link Budget		
Contribution	**Value**	**Comment**
Max Ground Station EIRP, dBW	83.8	7-m antenna
Tracking Error Ground Station, dB	-0.2	
Path Loss, $dB-m^2$	-162.5	40° elevation
Clear Sky Loss, dB	-0.3	
Isotropic Area, $dB-m^2$	-43.6	12750 MHz
BTA Gain (Sum Path), dB	34.7	USDBS
Polarization Loss, dB	-0.1	
Path Loss to CR, dB	-16.3	Ku-band; includes SSMA
Power at Cmd Rcvr input, dBW	-104.5	
Command Receiver Threshold, dBW	-135.0	
Command Margin, dB	36.4	
Rain Fade, dB	1.3	99.95% availability
Command Margin with Rain Fade, dB	34.1	
SpaceCast Ku-band On-station Pipe Command Link Budget		
Contribution	**Value**	**Comment**
Max Ground Station EIRP, dBW	83.8	7-m antenna
Tracking Error Ground Station, dB	-0.2	
Path Loss, $dB-m^2$	-162.5	40° elevation
Clear Sky Loss, dB	-0.3	
Isotropic Area, $dB-m^2$	-43.6	12750 MHz
BTA Gain (Sum Path), dB	3.7	On-axis (Ku-band)
Polarization Loss, dB	-3.0	Linear Transmit to Circular Receive
Path Loss to CR, dB	-6.3	
Power at Cmd Rcvr input, dBW	-128.4	Ku-band; includes SSMA
Command Receiver Threshold, dBW	-135.0	
Command Margin, dB	6.6	
Rain Fade, dB	1.3	99.95% availability
Command Margin with Rain Fade, dB	5.3	

Appendix B
Interference Analysis

APPENDIX B: INTERFERENCE ANALYSIS

This appendix presents C/I interference analyses and their results for scenarios involving SpaceCast™ and hypothetical GSO FSS systems.

A C/I analysis was performed to determine whether SpaceCast™ could share spectrum with a hypothetical GSO FSS system operating at V-band, referred to here as System-X. In scenario #1, the interfered-with satellite is System-X, which has the same parameters as a SpaceCast™ satellite. The C/I for scenario #1 is given in Table B-1. Parameters for interference analyses of this type are listed in Table B-3 for the uplink, and in Table B-4 for the downlink. In this type of scenario, a SpaceCast™ satellite and a System-X satellite are spaced 2° apart on the geostationary arc. This is approximately equivalent to a topographic angle of 2.2°. The interference budget for scenario #1 is shown in Table B-7. It shows that, at V-band, SpaceCast™ can operate 2° away from a similar system without harmfully interfering with it.

The interference budget for the reverse scenario, where System-X interferes with a SpaceCast™ satellite, is shown in Table B-9. Again, System-X has the parameters of a SpaceCast™ satellite. The two satellites are spaced 2° apart on the geostationary arc. The resulting C/I shows that, at V-band, SpaceCast™ can operate 2° away from a similar system without being harmfully interfered with.

Also, a C/I analysis was performed to determine whether SpaceCast™ could share spectrum with Expressway™. Expressway™ is a proposed GSO FSS system, which would operate in the same frequency bands as SpaceCast™. The parameters for this system are listed in Table B-3 for the uplink, and in Table B-4 for the downlink. First, the C/I for a SpaceCast™ satellite interfering with an Expressway™ satellite is calculated and listed under scenario #2 in Table B-1. The interference budget for this is given in Table B-8. Then, the C/I for the worst case interference, a scenario where an Expressway™ satellite interferes with a SpaceCast™ satellite, is calculated and given as scenario #4. The interference budget for scenario #4 is shown in Table B-10. In scenarios #2 and #4 in Table B-1, the two satellites are spaced 2° apart on the geostationary arc. Again, this is approximately equivalent to a topographic angle of 2.2°. The C/I results show that, for V-band operations, Expressway™ and SpaceCast™ are compatible when spaced 2° apart.

C/I analyses were also performed to determine whether SpaceCast™ could share spectrum with a hypothetical GSO FSS system operating at Ku-band, referred to here as System-Y. System-Y has earth station and space station characteristics derived from typical Ku-band satellite systems. The System-Y transponder bandwidth is assumed to be 30 MHz for satellite television signal transmissions. In interference scenarios, a SpaceCast™ satellite and a System-Y satellite are spaced 2° apart on the geostationary arc. The worst case scenario for SpaceCast™ interfering with System-Y is listed as scenario #5 in Table B-2. The worst case scenario for the reverse scenario, where System-Y interferes with SpaceCast™, is listed as scenario #7 in Table B-2. The parameters for SpaceCast™ and System-Y are given in Tables B-5 and B-6. The C/I results show that SpaceCast™ and a typical Ku-band system can operate spaced 2° apart without causing or receiving harmful interference.

Finally, C/I analyses were performed to determine whether SpaceCast™ could share spectrum with the Ku-band portion of Expressway™. In the interference scenarios, a SpaceCast™ satellite and an Expressway™ satellite are spaced 2° apart on the geostationary arc. The parameters for these two systems are given in Tables B-5 and B-6. The worst case scenarios are listed with their C/I values as scenarios #6 and #8 in Table B-2. The C/I results show that for Ku-band operations, Expressway™ and SpaceCast™ are compatible spaced 2° apart.

Scenario #5 is shown in Table B-11 as an example of how the C/I ratios for scenarios #5, 6, 7, and 8 are calculated.

Table B-1. C/I Ratios for Various V-Band Scenarios.

Interference Scenario	Interfer. E/S Trans. Ant. Diameter, Sidelobe Level	Interf. E/S Rec. Ant. Diameter	Desired E/S Trans. Ant. Diameter	Desired E/S Rec. Ant. Dia., Sidelobe Level	C/I, dB
1) SpaceCast™ interfer. with System-X	2.5 m, 29-25log(Theta)	0.45 m	2.5 m	0.45 m, 29-25log(Theta)	20.4
2) SpaceCast™ interfer. with Expressway™	2.5 m, 29-25log(Theta)	2.5 m	2.5 m	2.5 m, 29-25log(Theta)	27.4
3) System-X interfer. with SpaceCast™	2.5 m, 29-25log(Theta)	0.45 m	2.5 m	0.45 m, 29-25log(Theta)	20.4
4) Expressway™ interfer. with SpaceCast™	2.5 m, 29-25log(Theta)	2.5	2.5 m	1.0 m, 29-25log(Theta)	32.3

Table B-2. C/I Ratios for Various Ku-Band Scenarios.

Interference Scenario	Interfer. E/S Trans. Ant., Sidelobe Level	Interf. E/S Rec. Ant. Diameter	Desired E/S Trans. Ant. Diameter	Desired E/S Rec. Ant. Dia., Sidelobe Level	C/I, dB
5) SpaceCast™ interfer. with System-Y	2.5 m, 29-25log(Theta)	1.0 m	5.0 m	2.5 m, 29-25log(Theta)	25.4
6) SpaceCast™ interfer. with Expressway™ system	2.5 m, 29-25log(Theta)	2.5 m	2.5 m	2.5 m, 29-25log(Theta)	15.4
7) System-Y interfering with SpaceCast™	5.0 m, 29-25log(Theta)	2.5 m	2.5 m	1.0 m, 29-25log(Theta)	21.7[A]
8) Expressway™ interfer. with SpaceCast™	2.5 m, 29-25log(Theta)	2.5	2.5 m	1.0 m, 29-25log(Theta)	22.9

A. This is a single entry case: it is assumed that only one System-Y transponder with a bandwidth of approximately 30 MHz interferes with SpaceCast™. But, if System-Y has several transponders which fill the entire 214 MHz bandwidth of the SpaceCast™ satellite, the C/I will decrease by about 8.5 dB.

List of link parameters used in interference analyses

Table B-3. Uplink Parameter List for V-band Interference Analysis

Uplink Parameter	SpaceCast™	Expressway™	System-X
Signal Frequency, GHz (λ in m)	48.7 (0.006156)	48.7 (0.006156)	48.7 (0.006156)
Earth Sta. Trans. Pwr., W (dBW)	50 (17.0)	30 (14.8)	50 (17.0)
Earth Sta. HPA Pwr. Backoff, dB	2.5	3	2.5
Number of Carriers	1	1	1
Earth Sta. Transmitter Losses, dB	1.0	1.0	1.0
Earth Sta. Ant. Diam., m	2.5	2.5	2.5
Earth Sta. Trans. Ant. On-Axis Gain, dBi	59.5 (η=0.55)	59.5 (η=0.55)	59.5 (η=0.55)
Earth Sta. Ant. Off-Axis Gain Pattern, dBi	29-25log(Theta)	29-25log(Theta)	29-25log(Theta)
Satellite Max. Rec. Ant. Gain, dBi	58.0	52.0	58.0
Satellite Edge-of-Coverage Rec. Ant. Gain, dBi	55.0	49.0	55.0
Single Carrier Channel Bandwidth, MHz	300	300	300

Table B-4. Downlink Parameter List for V-band Interference Analysis

Downlink Parameter	SpaceCast™	Expressway™	System-X
Signal Frequency, GHz (λ in m)	41.0 (.007312)	41.0 (.007312)	41.0 (.007312)
Satellite Trans. Pwr., W (dBW)	100 (20.0)	100 (20.0)	100 (20.0)
Satellite HPA Pwr. Backoff, dB	2	2	2
Number of Carriers	10	10	10
Satellite Transmitter Losses, dB	1.0	1.0	1.0
Satellite Max. Trans. Ant. Gain, dBi	58.0	52.0	58.0
Satellite Edge-of-Coverage Trans. Ant. Gain, dBi	55.0	49.0	55.0
Earth Sta. Ant. Diameter, m	0.45, 1.0, 2.5	2.5	0.45, 1.0, 2.5
Earth Sta. Rec. Ant. On-Axis Gain, dBi	43.9, 50.8, 58.0 (η=0.65, 0.65, 0.55)	58.0	43.9, 50.8, 58.0 (η=0.65, 0.65, 0.55)
Earth Sta. Ant. Off-Axis Gain Pattern, dBi	29-25log(Theta)	29-25log(Theta)	29-25log(Theta)
Single Carrier Channel Bandwidth, MHz	300	300	300

Table B-5. Uplink Parameter List for Ku-band Interference Analysis

Uplink Parameter	SpaceCast™	Expressway™	System-Y
Signal Frequency, GHz (λ in m)	13.0 (0.02306)	13.0 (0.02306)	13.0 (0.02306)
Earth Sta. Trans. Pwr., W (dBW)	100 (20.0)	100 (20.0)	50 (17.0)
Earth Sta. HPA Pwr. Backoff, dB	1.0	1.0	0
Number of Carriers	1	1	1
Earth Sta. Transmitter Losses, dB	0.3	0.3	0.3
Earth Sta. Ant. Diam., m	2.5	2.5	5
Earth Sta. Trans. Ant. On-Axis Gain, dBi	48.8 (η=0.65)	48.8	54.1 (η=0.55)
Earth Sta. Ant. Off-Axis Gain Pattern, dBi	29-25log(Theta)	29-25log(Theta)	29-25log(Theta)
Satellite Max. Rec. Ant. Gain, dBi	37.0	37.0	35
Satellite Edge-of-Coverage Rec. Ant. Gain, dBi	34.0	34.0	32
Single Carrier Bandwidth, MHz	214	240	30

Table B-6. Downlink Parameter List for Ku-band Interference Analysis

Downlink Parameter	SpaceCast™	Expressway™	System-Y
Signal Frequency, GHz (λ in m)	11.0 (.02725)	11.0 (.02725)	11.0 (.02725)
Satellite Trans. Pwr., W (dBW)	150 (21.8)	25 (14.0)	50 (17.0)
Satellite HPA Pwr. Backoff, dB	0	0	0
Number of Carriers	1	1	1
Satellite Transmitter Losses, dB	0.6	0.5	0.5
Satellite Max. Trans. Ant. Gain, dBi	37.0	37.0	35
Satellite Edge-of-Coverage Trans. Ant. Gain, dBi	34.0	34.0	32
Earth Sta. Ant. Diameter, m	1.0, 2.5	2.5	2.5
Earth Sta. Rec. Ant. On-Axis Gain, dBi	39.7, 47.3 (η=0.70, 0.65)	47.3	47.3 (η=0.65)
Earth Sta. Ant. Off-Axis Gain Pattern, dBi	29-25log(Theta)	29-25log(Theta)	29-25log(Theta)
Single Carrier Bandwidth, MHz	214	240	30

Interference analyses: typical calculations

Table B-7. V-band Interference Analysis: SpaceCast™ Interfering With System-X, Scenario #1 (2° separation)

Uplink Budget Item	Value	Unit
Interf. (SpaceCast™) E/S TX Power	17.0	dBW
Interf. E/S HPA Backoff	-2.5	dB
Per Carrier Loss	-0.0	dB
Interf. E/S TX losses	-1.0	dB
Interf. E/S Ant. Trans. Gain toward X Sat.	20.4	dBi
EIRP toward X Sat.	33.9	dBW
Interfering Trans. BW Mismatch	0.0	dB
Space Loss(217.6)[A] + Atm. Loss (4.6)	-222.2	dB
Max. X Satellite Rec. Ant. Gain	58.0	dBi
$(I)_{uplink}$	**-130.3**	**dBW**
Desired (System-X) E/S TX Power	17.0	dBW
Desired E/S HPA Backoff	-2.5	dB
Per Carrier Loss	-0.0	dB
Desired E/S TX losses	-1.0	dB
Desired E/S Ant. Trans. Gain On-Axis (2.5 m, effic. = 0.55)	59.5	dBi
EIRP	73.0	dBW
Space Loss(217.6)[A] + Atm. Loss (4.6)	-222.2	dB
X Sat. Edge-of-Coverage Rec. Ant. Gain	55.0	dBi
$(C)_{uplink}$	**-94.2**	**dBW**
$(C/I)_{uplink} = (C)_{uplink} - (I)_{uplink}$	**36.1**	**dB**

A. Assuming 37,000 km slant range; other losses also assumed to be the same for the interfering signal and the desired signal.

Table B-7. V-band Interference Analysis: SpaceCast™ Interfering With System-X, Scenario #1 (2° separation) (cont'd)

Downlink Budget Item	Value	Unit
Interf. Satell. (SpaceCast™) TX Pwr.	20.0	dBW
Interf. Satellite HPA Backoff	-2.0	dB
Per Carrier Loss	-10.0	dB
Interf. Satellite TX losses	-1.0	dB
Max. Interf. Satellite Trans. Ant. Gain	58.0	dBi
EIRP toward System-X E/S	65.0	dBW
Interfering Trans. BW Mismatch	0.0	dB
Space Loss(216.1)[A] + Atm. Loss (2.6)	-218.7	dB
Sys.-X E/S Ant. Rec. Gain toward Interf. Satell.	20.4	dBi
$(I)_{downlink}$	**-133.3**	**dBW**
Desired X-Satellite TX Power	20.0	dBW
Desired X-Satellite HPA Backoff	-2.0	dB
Per Carrier Loss	-10.0	dB
Desired X-Satellite TX losses	-1.0	dB
Desired X-Satell. Edge-of-Coverage Trans. Ant. Gain	55.0	dBi
EIRP	62.0	dBW
Space Loss(216.1)[A] + Atm. Loss (2.6)	-218.7	dB
Sys.-X E/S Ant. Rec. Gain On-Axis (0.45 m dia., effic. = 0.65)	43.9	dBi
$(C)_{downlink}$	**-112.8**	**dBW**
$(C/I)_{downlink} = (C)_{downlink} - (I)_{downlink}$	**20.5**	**dB**
$C/I = ((C/I)_{uplink}^{-1} + (C/I)_{downlink}^{-1})^{-1}$	**20.4**	**dB**

A. Assuming 37,000 km slant range; other losses also assumed to be the same for the interfering signal and the desired signal.

Table B-8. V-band Interference Analysis: SpaceCast™ Interfering With Expressway™, Scenario #2 (2° separation)

Uplink Budget Item	Value	Unit
Interf. (SpaceCast™) E/S TX Power	17.0	dBW
Interf. E/S HPA Backoff	-2.5	dB
Per Carrier Loss	-0.0	dB
Interf. E/S TX losses	-1.0	dB
Interf. E/S Ant. Trans. Gain toward Expressway™ Sat.	20.4	dBi
EIRP toward Expressway™ Sat.	33.9	dBW
Interfering Trans. BW Mismatch	0.0	dB
Space Loss(217.6)[A] + Atm. Loss (4.6)	-222.2	dB
Max. Expressway™ Satellite Rec. Ant. Gain	52.0	dBi
$(I)_{uplink}$	**-136.3**	**dBW**
Desired(Expressway™) E/S TX Pwr	14.8	dBW
Desired E/S HPA Backoff	-3.0	dB
Per Carrier Loss	-0.0	dB
Desired E/S TX losses	-1.0	dB
Desired E/S Ant. Trans. Gain On-Axis	59.5	dBi
EIRP	70.3	dBW
Space Loss(217.6)[A] + Atm. Loss (4.6)	-222.2	dB
Expressway™ Sat. Edge-of-Coverage Rec. Ant. Gain	49.0	dBi
$(C)_{uplink}$	**-102.9**	**dBW**
$(C/I)_{uplink} = (C)_{uplink} - (I)_{uplink}$	**33.4**	**dB**

A. Assuming 37,000 km slant range; other losses also assumed to be the same for the interfering signal and the desired signal.

Table B-8. V-band Interference Analysis: SpaceCast™ Interfering With Expressway™, Scenario #2 (2° separation) (cont'd)

Downlink Budget Item	Value	Unit
Interf. Satell. (SpaceCast™) TX Pwr.	20.0	dBW
Interf. Satellite HPA Backoff	-2.0	dB
Per Carrier Loss	-10.0	dB
Interf. Satellite TX losses	-1.0	dB
Max. Interf. Satellite Trans. Ant. Gain	58.0	dBi
EIRP toward Expressway™ E/S	65.0	dBW
Interfering Trans. BW Mismatch	0.0	dB
Space Loss(216.1)[A] + Atm. Loss (2.6)	-218.7	dB
Expressway™ E/S Ant. Rec. Gain toward Interf. Satell.	20.4	dBi
$(I)_{downlink}$	**-133.3**	**dBW**
Desired(Expressway™) Sat. TX Pwr.	20.0	dBW
Desired Satellite HPA Bkoff.	-2.0	dB
Per Carrier Loss	-10.0	dB
Desired Satellite TX losses	-1.0	dB
Desired Satellite Edge-of-Coverage Trans. Ant. Gain	49.0	dBi
EIRP	56.0	dBW
Space Loss(216.1)[A] + Atm. Loss (2.6)	-218.7	dB
Expressway™ E/S Ant. Rec. Gain On-Axis	58.0	dBi
$(C)_{downlink}$	**-104.7**	**dBW**
$(C/I)_{downlink} = (C)_{downlink} - (I)_{downlink}$	**28.6**	**dB**
$C/I = ((C/I)_{uplink}^{-1} + (C/I)_{downlink}^{-1})^{-1}$	**27.4**	**dB**

A. Assuming 37,000 km slant range; other losses also assumed to be the same for the interfering signal and the desired signal.

Table B-9. V-band Interference Analysis: System-X Interfering With SpaceCast™, Scenario #3 (2° separation)

Uplink Budget Item	Value	Unit
Interf. (System-X) E/S TX Power	17.0	dBW
Interf. E/S HPA Backoff	-2.5	dB
Per Carrier Loss	-0.0	dB
Interf. E/S TX losses	-1.0	dB
Interf. E/S Ant. Trans. Gain toward SpaceCast™ Sat.	20.4	dBi
EIRP toward SpaceCast™ Sat.	33.9	dBW
Interfering Trans. BW Mismatch	0.0	dB
Space Loss(217.6)[A] + Atm. Loss (4.6)	-222.2	dB
Max. SpaceCast™ Satellite Rec. Ant. Gain	58.0	dBi
$(I)_{uplink}$	**-130.3**	**dBW**
Desired (SpaceCast™) E/S TX Power	17.0	dBW
Desired E/S HPA Backoff	-2.5	dB
Per Carrier Loss	-0.0	dB
Desired E/S TX losses	-1.0	dB
Desired E/S Ant. Trans. Gain On-Axis (2.5 m, effic. = 0.55)	59.5	dBi
EIRP	73.0	dBW
Space Loss(217.6)[A] + Atm. Loss (4.6)	-222.2	dB
SpaceCast™ Sat. Edge-of-Coverage Rec. Ant. Gain	55.0	dBi
$(C)_{uplink}$	**-94.2**	**dBW**
$(C/I)_{uplink} = (C)_{uplink} - (I)_{uplink}$	**36.1**	**dB**

A. Assuming 37,000 km slant range; other losses also assumed to be the same for the interfering signal and the desired signal.

Table B-9. V-band Interference Analysis: System-X Interfering With SpaceCast™, Scenario #3 (2° separation) (cont'd)

Downlink Budget Item	Value	Unit
Interf. Satell. (System-X) TX Pwr.	20.0	dBW
Interf. Satellite HPA Backoff	-2.0	dB
Per Carrier Loss	-10.0	dB
Interf. Satellite TX losses	-1.0	dB
Max. Interf. Satellite Trans. Ant. Gain	58.0	dBi
EIRP toward SpaceCast™ E/S	65.0	dBW
Interfering Trans. BW Mismatch	0.0	dB
Space Loss(216.1)[A] + Atm. Loss (2.6)	-218.7	dB
SpaceCast™ E/S Ant. Rec. Gain toward Interf. Satell.	20.4	dBi
$(I)_{downlink}$	**-133.3**	**dBW**
Desired (SpaceCast™) Satellite TX Power	20.0	dBW
Desired Satellite HPA Backoff	-2.0	dB
Per Carrier Loss	-10.0	dB
Desired Satellite TX losses	-1.0	dB
Desired Satell. Edge-of-Coverage Trans. Ant. Gain	55.0	dBi
EIRP	62.0	dBW
Space Loss(216.1)[A] + Atm. Loss (2.6)	-218.7	dB
SpaceCast™ E/S Ant. Rec. Gain On-Axis (0.45 m dia., effic. = 0.65)	43.9	dBi
$(C)_{downlink}$	**-112.8**	**dBW**
$(C/I)_{downlink} = (C)_{downlink} - (I)_{downlink}$	**20.5**	**dB**
$C/I = \left((C/I)_{uplink}^{-1} + (C/I)_{downlink}^{-1} \right)^{-1}$	**20.4**	**dB**

A. Assuming 37,000 km slant range; other losses also assumed to be the same for the interfering signal and the desired signal.

Table B-10. V-band Interference Analysis: Expressway™ Interfering With SpaceCast™, Scenario #4 (2° separation)

Uplink Budget Item	Value	Unit
Interf. (Expressway™) E/S TX Power	14.8	dBW
Interf. E/S HPA Backoff	-3.0	dB
Per Carrier Loss	-0.0	dB
Interf. E/S TX losses	-1.0	dB
Interf. E/S Ant. Trans. Gain toward SpaceCast™ Sat.	20.4	dBi
EIRP toward SpaceCast™ Sat.	31.2	dBW
Interfering Trans. BW Mismatch	-0.0	dB
Space Loss(217.6)[A] + Atm. Loss (4.6)	-222.2	dB
Max. SpaceCast™ Satellite Rec. Ant. Gain	58.0	dBi
$(I)_{uplink}$	**-133.0**	**dBW**
Desired (SpaceCast™) E/S TX Power	17.0	dBW
Desired E/S HPA Backoff	-2.5	dB
Per Carrier Loss	-0.0	dB
Desired E/S TX losses	-1.0	dB
Desired E/S Ant. Trans. Gain On-Axis (2.5 m, effic. = 0.55)	59.5	dBi
EIRP	73.0	dBW
Space Loss(217.6)[A] + Atm. Loss (4.6)	-222.2	dB
SpaceCast™ Sat. Edge-of-Coverage Rec. Ant. Gain	55.0	dBi
$(C)_{uplink}$	**-94.2**	**dBW**
$(C/I)_{uplink} = (C)_{uplink} - (I)_{uplink}$	**38.8**	**dB**

A. Assuming 37,000 km slant range; other losses also assumed to be the same for the interfering signal and the desired signal.

Table B-10. V-band Interference Analysis: Expressway™ Interfering With SpaceCast™, Scenario #4 (2° separation) (cont'd)

Downlink Budget Item	Value	Unit
Interf. Satell. (Expressway™) TX Pwr.	20.0	dBW
Interf. Satellite HPA Backoff	-2.0	dB
Per Carrier Loss	-10.0	dB
Interf. Satellite TX losses	-1.0	dB
Max. Interf. Satellite Trans. Ant. Gain	52.0	dBi
EIRP toward SpaceCast™ E/S	59.0	dBW
Interfering Trans. BW Mismatch	-0.0	dB
Space Loss(216.1)[A] + Atm. Loss (2.6)	-218.7	dB
SpaceCast™ E/S Ant. Rec. Gain toward Interf. Satell.	20.4	dBi
$(I)_{downlink}$	**-139.3**	**dBW**
Desired (SpaceCast™) Satellite TX Power	20.0	dBW
Desired Satellite HPA Backoff	-2.0	dB
Per Carrier Loss	-10.0	dB
Desired Satellite TX losses	-1.0	dB
Desired Satell. Edge-of-Coverage Trans. Ant. Gain	55.0	dBi
EIRP	62.0	dBW
Space Loss(216.1)[A] + Atm. Loss (2.6)	-218.7	dB
SpaceCast™ E/S Ant. Rec. Gain On-Axis (1.0 m dia.[B], effic. = 0.65)	50.8	dBi
$(C)_{downlink}$	**-105.9**	**dBW**
$(C/I)_{downlink} = (C)_{downlink} - (I)_{downlink}$	**33.4**	**dB**
$C/I = ((C/I)_{uplink}^{-1} + (C/I)_{downlink}^{-1})^{-1}$	**32.3**	**dB**

A. Assuming 37,000 km slant range; other losses also assumed to be the same for the interfering signal and the desired signal.

B. Because a SpaceCast™ earth station's receiver bandwidth varies as a function of its antenna size, the 1.0-m antenna receiver is the worst case, not the 0.45-m antenna receiver.

Table B-11. Ku-band Interference Analysis: SpaceCast™ Interfering With System-Y, Scenario #5 (2° separation)

Uplink Budget Item	Value	Unit
Interf. (SpaceCast™) E/S TX Power	20.0	dBW
Interf. E/S HPA Backoff	-1.0	dB
Per Carrier Loss	0.0	dB
Interf. E/S TX losses	-0.3	dB
Interf. E/S Ant. Trans. Gain toward Y Sat.	20.4	dBi
EIRP toward Y Sat.	39.1	dBW
Interfering Trans. BW Mismatch	-8.5	dB
Space Loss (206.1)[A] + Atm. Loss (0.5)	-206.6	dB
Max. Y Satellite Rec. Ant. Gain	35.0	dBi
$(I)_{uplink}$	**-141.0**	**dBW**
Desired (System-Y) E/S TX Power	17.0	dBW
Desired E/S HPA Backoff	0.0	dB
Per Carrier Loss	0.0	dB
Desired E/S TX losses	-0.3	dB
Desired E/S Ant. Trans. Gain On-Axis (5 m dia., effic. = 0.55)	54.1	dBi
EIRP	70.8	dBW
Space Loss (206.1)[A] + Atm. Loss (0.5)	-206.6	dB
Y Sat. Edge-of-Coverage Rec. Ant. Gain	32.0	dBi
$(C)_{uplink}$	**-103.8**	**dBW**
$(C/I)_{uplink} = (C)_{uplink} - (I)_{uplink}$	**37.2**	**dB**

A. Assuming 37,000 km slant range; other losses also assumed to be the same for the interfering signal and the desired signal.

Table B-11. Ku-band Interference Analysis: SpaceCast™ Interfering With System-Y, Scenario #5 (2° separation) (cont'd)

Downlink Budget Item	Value	Unit
Interf. Satell. (SpaceCast™) TX Pwr.	21.8	dBW
Interf. Satellite HPA Backoff	-0.0	dB
Per Carrier Loss	-0.0	dB
Interf. Satellite TX losses	-0.6	dB
Max. Interf. Satellite Trans. Ant. Gain	37.0	dBi
EIRP toward System-Y E/S	58.2	dBW
Interfering Trans. BW Mismatch	-8.5	dB
Space Loss (204.6)[A] + Atm. Loss (0.2)	-204.8	dB
Sys.-Y E/S Ant. Rec. Gain toward Interf. Satell.	20.4	dBi
$(I)_{downlink}$	**-134.7**	**dBW**
Desired Y-Satellite TX Power	17.0	dBW
Desired Y-Satellite HPA Backoff	-0.0	dB
Per Carrier Loss	-0.0	dB
Desired Y-Satellite TX losses	-0.5	dB
Desired Y-Satell. Edge-of-Coverage Trans. Ant. Gain	32.0	dBi
EIRP	48.5	dBW
Space Loss (204.6)[A] + Atm. Loss (0.2)	-204.8	dB
Sys.-Y E/S Ant. Rec. Gain On-Axis (2.5 m dia., effic. = 0.65)	47.3	dBi
$(C)_{downlink}$	**-109.0**	**dBW**
$(C/I)_{downlink} = (C)_{downlink} - (I)_{downlink}$	**25.7**	**dB**
$C/I = ((C/I)_{uplink}^{-1} + (C/I)_{downlink}^{-1})^{-1}$	**25.4**	**dB**

A. Assuming 37,000 km slant range; other losses also assumed to be the same for the interfering signal and the desired signal.

Appendix C
Antenna Coverage

APPENDIX C: ANTENNA COVERAGE

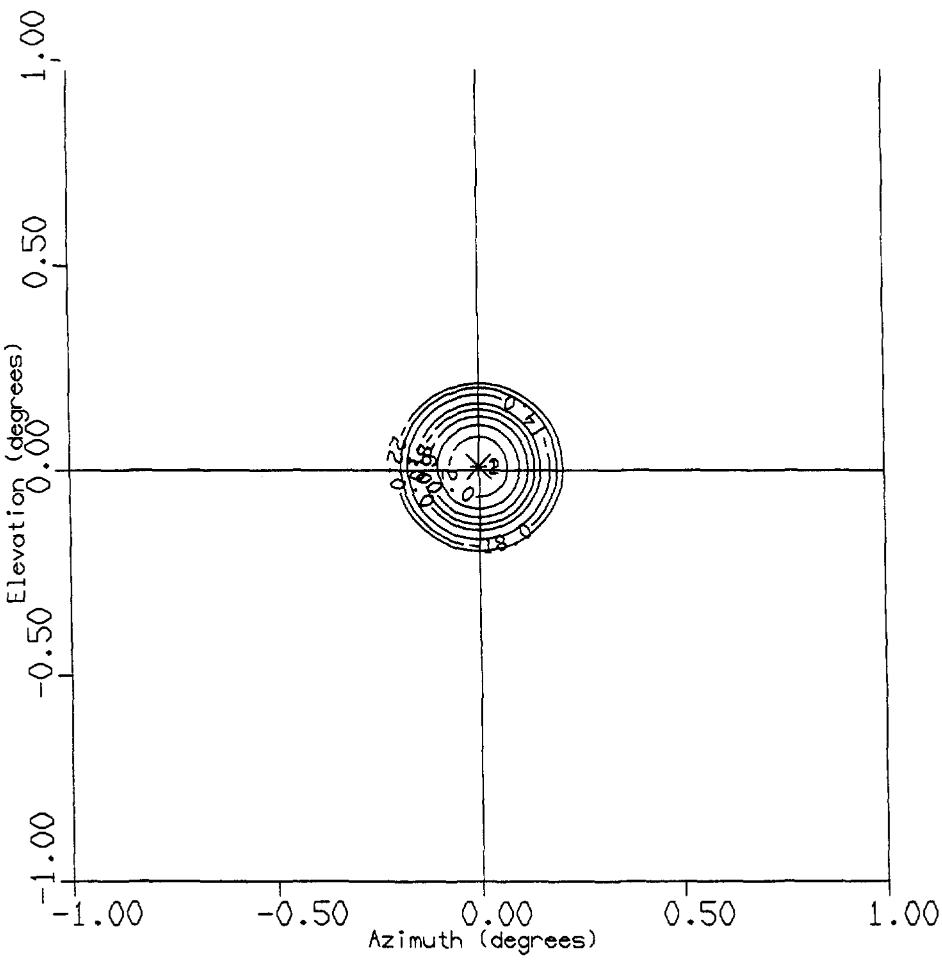


Figure C-1. V-band Receive/Transmit Satellite Antenna Gain Contours. For both RHCP and LHCP. Maximum gain = 58 dBi, maximum G/T = 29.4 dB/K.

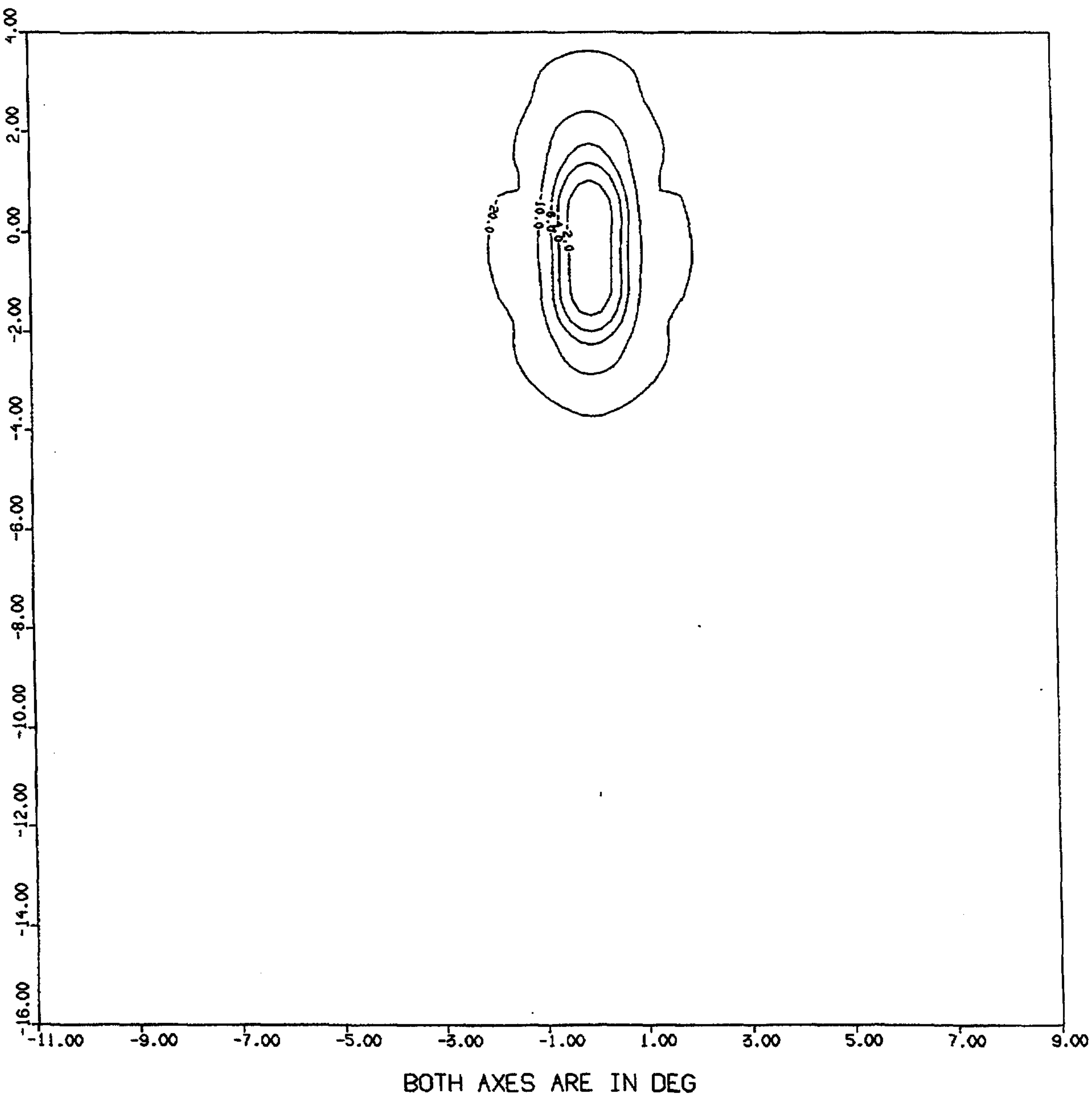
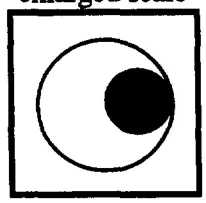


Figure C-2. Ku-Band Receive/Transmit Elliptical Beam Contours. For both RHCP and LHCP. Maximum gain = 37 dBi, maximum G/T = 10.9 dB/K.

Each 0.15 deg beam is steerable within a 0.30 deg circle. Map shows 0.30 deg coverage circles. Box shows 0.15 deg beam inside a 0.30 deg beam. The 0.15 deg beams will be deployed over a maximum of 40 uplink and 40 downlink areas within the coverage shown.

beam use @
enlarged scale



39 W

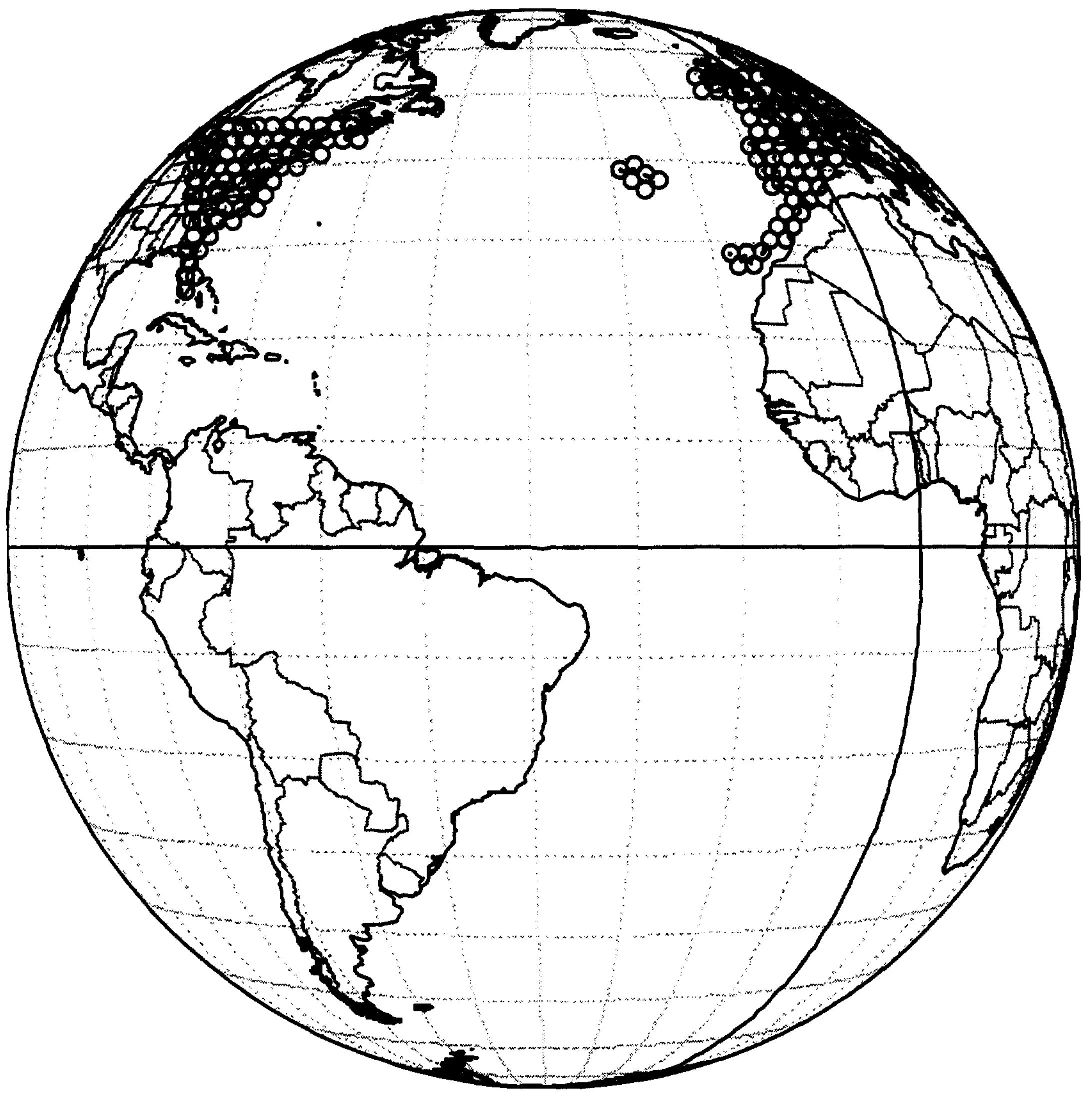


Figure C-3. V-band Satellite Coverage at 39° W